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REPORT OF THE INTERNATIONAL JOINT COMMISSION, UNITED STATES AND CANADA ON THE POLLUTION OF THE ATMOSPHERE IN THE DETROIT RIVER AREA

International Joint Commission-United States and Canada

December 1960

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INTERNATIONAL JOINT COMMISSION

WASHINGTON, D.C., U.S.A. - OTTAWA, ONTARIO, CANADA

DECEMBER 1960

ERRATA TO DETROIT RIVER AREA AIR POLLUTION REPORT

The "Report of the International Joint Commission, United States and Canada, on the Pollution of the Atmosphere in the Detroit River Area" (1960) was submitted to the governments of the United States and Canada on 27 June 1960. Since that time the Commission's Technical Advisory Board has learned of an error in the report. The Commission regrets any difficulty which may have occurred because of this error. No changes in the recommendations contained in the report are necessary. The following changes should be made in the Commission's report. A separate errata applies to the Technical Advisory Board's report to the Commission.

Page 3, right column, line 16: change 1270 to 770.

Page 3, right column, line 18: place a period after "dioxide" and delete the rest of this line and the following three lines.

Page 3, right column, line 24: change 1040 to 540.

Report

OF THE

INTERNATIONAL JOINT COMMISSION

UNITED STATES AND CANADA

ON THE

Pollution of the Atmosphere

in the

Detroit River Area

WASHINGTON 1960 OTTAWA

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LETTER OF TRANSMITTAL

The following letter was sent to the Secretary of State, Washington, D.C., by the secretary of the United States Section of the International Joint Commission and to the Secretary of State for External Affairs, Ottawa, Canada, by the secretary of the Canadian Section of the International Joint Commission:

27 June 1960

Sir,

I have the honor to transmit to you the "Report of the International Joint Commission, United States and Canada, on the Pollution of the Atmosphere in the Detroit River Area", dated 31 May 1960.

Under the reference of 12 January 1949, the Commission was requested by the Governments to inquire into and report upon the pollution of the air in the vicinity of the cities of Detroit and Windsor on either side of the international boundary in the area of the Detroit River. A copy of the report of the Technical Advisory Board of 1959, addressed to the Commission, is appended and forms part of the report of the International Joint Commission.

Yours sincerely,

Harry J. Donohue
Secretary, United States Section

David G. Chance
Secretary, Canadian Section

Report of

THE INTERNATIONAL JOINT COMMISSION

United States and Canada

On The

Pollution of the Atmosphere

In The

Detroit River Area

The Secretary of State for the Government of the United States and the Prime Minister for the Government of Canada, on January 12, 1949, made the following Reference to the International Joint Commission through identical letters addressed to United States and Canadian Sections of the Commission:

"I have the honor to inform you that representations have been made to the Governments of the United States and Canada to the effect that the air in the vicinity of the cities of Detroit and Windsor on both sides of the international boundary in the area of the Detroit River, is being polluted by the discharge of smoke, soot and fly ash, in quantities sufficient to be detrimental to the public health, safety and general welfare of the citizens of both countries in this area. It has further been represented to the two Governments that vessels passing through the Detroit River are a source of this pollution. Pursuant to the provisions of Article IX of the Boundary Waters Treaty, signed January 11, 1909, the two Governments have agreed to a joint reference of this matter to the International Joint Commission. The Commission is requested to enquire into, and to report to the two Governments upon the following questions:

1. Is the air over, and in the vicinity of, the cities of Detroit and Windsor, on either side of the international boundary, being polluted by smoke, soot, fly ash, or other impurities, in quantities detrimental to the public health, safety or general welfare of the citizens, or to property interests on either side of the international boundary line?

2. If the foregoing question, or any part thereof, is answered in the affirmative, to what extent are vessels plying the waters of the Detroit River, or any of them, contributing to this pollution; what other major factors are responsible and to what extent?

3. If the Commission should find that vessels plying the waters of the Detroit River, or any of them, are responsible for air pollution to an extent detrimental to the public health, safety or general welfare of the citizens, or to the property interests on either side of the international boundary line,

   (a) what preventive or remedial measures would, in its judgment, be most practical from the economic, sanitary and other points of view?

   (b) what would be the probable cost of such measures?

   (c) by whom should such cost be borne?

For the purpose of assisting the Commission is making the investigations and recommendations provided for in this reference, the two Governments, upon request, will make available to the Commission the services of engineers and other specially qualified personnel of their respective Governments, and such information and technical data as may have been acquired by such Governments or as may be acquired by them during the course of the investigation.

The Commission should submit its report and recommendations to the two Governments as soon as practicable."

APPOINTMENT OF THE TECHNICAL ADVISORY BOARD

Following receipt of the Reference, the Commission, in April 1949, appointed a board of three experts from the United States and three from Canada from personnel made available by the two Federal Governments and the Province of Ontario to act as technical advisers and supervise the conduct of the investigation. Membership of this Technical Advisory Board was increased from six to eight in April 1954, by the addition of two medical experts, one representing the Detroit Department of Health and the other from the Department of National Health and Welfare, Ottawa.

As presently constituted the Technical Advisory Board consists of - for Canada - Dr. Morris Katz, Chairman, Dr. Clare M. Jephcott, Dr. Thomas H. Patterson, and Mr. J. Ross Menzies; for the United States - Mr. Arthur C. Stern, Chairman, Dr. Charles P. Anderson, Dr. Louis C. McCabe, and Mr. John F. Barkley. Previous Board chairmen and members were - for Canada - Members - Dr. E. A. Watkinson and Dr. A.E.R. Westman; for the United States - Chairmen - Dr. A. T. Rossano, Jr., Mr. G.D. Clayton, and Mr. L.M. Fisher and Members - Dr. H.A. Schrenk, Mr. C.H. Atkins, and Mr. P.D. Haney. For the United States the present Secretary to the Board is Dr. Roy O. McCaldin. The former Secretary was Mr. Jean J. Schueneman.

DESCRIPTION OF THE AREA

This report covers the area specified broadly in the Reference as that located in the vicinity of Detroit and Windsor, including the Detroit River. On the United States side of the international boundary this includes all of Wayne County and the southern portions of Macomb and Oakland Counties in Michigan. On the Canadian side this includes the western portion of Essex County in Ontario. This is a highly industrialized area with an estimated population in 1955 of nearly 3.5 million. There are 6,400 industrial establishments in the area employing about 750,000 persons; of these, about 30,000 persons are employed in 450 industries in the Windsor area. Most of the industries are in Wayne County, Michigan, with the heaviest industrialization along the Detroit and Rouge Rivers. The predominant industries are automobile manufacture, ordnance, primary metals, fabricated metals, and machinery.

ORGANIZATION AND PROCEDURE OF THE INVESTIGATION

Comprehensive scientific and engineering studies and field surveys of the atmospheric pollution problem required for the purpose of the Reference were organized by the Technical Advisory Board and carried out through the cooperation of the appropriate Federal, State and Provincial, Municipal and other agencies concerned, including the Lake Carriers' and Dominion Marine Associations. A detailed account of the investigation is given in the report of the Technical Advisory Board which is appended and forms part of this report.

In order to provide the necessary information under the terms of the Reference, studies were carried out to determine the sources, nature and concentration levels of major atmospheric contaminants resulting from combustion of fuels and industrial processes, the influence of meteorological factors on dispersion and diffusion of these contaminants, the extent of transboundary flow of pollution and the effects of pollution upon public health and welfare, vegetation and visibility. The problem of excessive smoke emission from vessels plying the Detroit River was given major consideration and, in accordance with the terms of the Reference, studies were also carried out to determine the control and remedial measures necessary to abate pollution from this source, including the probable cost of such measures.

Smoke measurements based on the Ringelmann Chart method were commenced in July 1949 and have been continued in each navigation season since then. The Canadian Section of the Board has had the main responsibility for the compilation of these data which cover from 450 to 650 vessels in some 2,500 to 4,500 passages of the river during a navigation season. Annual reports concerning the smoke performance of vessels in relation to firing equipment have been distributed to vessel owners and operators on the Great Lakes, to the Dominion Marine and Lake Carriers' Associations, to municipalities along the Detroit River and to other interested agencies.

In 1952, the Commission approved, on an annual basis, the establishment of "smoke emission objectives" that define the limits of smoke in terms of Ringelmann number and time for various types of fuel-burning equipment installed on vessels passing through the Detroit River. In the succeeding years these objectives were made progressively more stringent until 1955. These objectives and the frequent

dissemination during the navigation season to ship owners or operators of information on smoke emission observations made on their vessels have formed the foundation of a voluntary control program that has had the active cooperation and support of a large majority of those concerned, including the vessel owner associations and the air pollution control officers of municipalities along the Detroit River.

Three public hearings have been held by the Commission to assess the results of the vessel smoke studies and progress in the voluntary control program, to obtain information on remedial measures and estimates of costs of automatic fuelburning installations to alleviate air pollution from vessels, to determine the time required for the institution of necessary pollution control measures and to obtain the views of all interested parties towards proposals for setting appropriate emission standards for pollution control. These hearings took place as follows:

Detroit, Michigan	October 18 & 19, 1950
Detroit, Michigan	June 5, 1953
Detroit, Michigan	February 19, 1958

FINDINGS

The findings of the Commission, after consideration of the results of the investigation and the evidence presented at the Commission's hearings, are outlined below.

NATURE AND EXTENT OF THE POLLUTION PROBLEM:

The extensive scale and variety of land-based industrial and commercial operations, the large amount of traffic on land and water, as well as the use of large quantities of fuel for domestic and industrial purposes and other activities of the public, generate large quantities of atmospheric contaminants of many varieties. These consist of smoke, soot, fly ash, and other particulate matter, sulfur dioxide, oxides of nitrogen, aldehydes, and other gaseous and vapor contaminants. The consumption of solid fuel in land-based industrial, commercial, and domestic fuel-burning equipment was established in 1954-1955 to total 12,244,000 tons annually. At the same time the total annual consumption of fuel oil and natural gas was 2,920,000 and 3,832,500 tons respectively. In contrast to this, the solid fuel consumption by vessels during passages of the Detroit River in an average navigation season has been estimated at about 108,000 tons. Thus, over the eight month navigation season this fuel consumption by vessels represents only about 1.5 percent of the total solid fuel burned in the study area in a comparable period. However, the land-based sources are distributed over a comparatively large area within the approximately 900 square mile region under study, whereas the smoke and fly ash deposition on land from vessels is centered in a narrow belt adjoining the Detroit River.

The total emissions to the atmosphere of contaminants in 1956 were estimated to be about 4,000 tons per day of gases such as sulfur oxides, nitrogen oxides, acids, organics and unspecified gases, and 1,270 tons of solids. These totals do not include carbon monoxide and carbon dioxide or the particulate matter discharged from blast furnaces, steel furnaces, or iron and steel foundries, as these emissions could not be estimated with sufficient accuracy. Of this total, industry and commerce contributed 1,980 tons per day in the form of gaseous and vapor contaminants and 1,040 tons in the form of solids. The remainder came from other sources such as fuel used in domestic heating equipment and motor vehicles.

The results of environmental studies indicate that the most heavily polluted areas lie close to the Detroit River and adjacent to major industrial operations. The amount of dust deposition is about two to three times higher in industrial-commercial districts than in residential sections of Detroit or Windsor. It was found that the Windsor high pollution area contained monthly mean loadings of air-borne particulate matter that were about two to six times the mean concentrations found at Harrow, Ontario, about 25 miles distant from the Detroit River.

Mean concentrations of sulfur dioxide pollution in the industrial areas of Windsor were found to be about five to more than seven times the mean concentrations at points in Ontario 15 to 25 miles distant from the Detroit River. The maximum monthly mean concentration in the industrial part of Windsor was about ten times the maximum monthly mean concentration of sulfur dioxide at Harrow, Ontario. In Detroit, the mean sulfur dioxide levels in the high pollution area were about twice as high as the level in the Windsor high pollution area.

EFFECTS OF THE POLLUTION

The possible effects of air pollution on health were investigated in a two-year pilot study of

groups of households in a number of residential areas on both sides of the Detroit River. During this period, the concentrations of principal air contaminants in the study area were determined. It was found that the monthly rates of sickness in all areas under study followed a similar chronological pattern, although at differing levels. However, two areas in Detroit showed a pattern of sickness rates that differed substantially from each other. The rates in the high pollution area were generally at a greater level than those in the low pollution area. In other groups of households in Detroit and in Windsor, the results were inconclusive. Thus, some effect on health was demonstrated although the elucidation of the quantitative relationship between atmospheric contamination and sickness experience and health clearly requires further study.

General observations on vegetation throughout the study area were carried out by a survey team in an attempt to determine the nature and extent of injury from air pollution, particularly in the vicinity of probable sources of pollutants. The work was complicated by the fact that present knowledge of the effects of urban air pollution on vegetation is incomplete. The presence in the urban atmosphere of various particulate and gaseous pollutants tended to complicate the evaluation of nonspecific symptoms on the leaves of plants. In the case of nonspecific complaints of poor growth in urban areas, inadequate soil moisture, poor drainage, nutritional imbalances and cultural practices may be contributing factors. Although the results of the surveys did not indicate the presence of a general repressive effect on vegetation due to air pollution, injury to certain species of vegetation was found on both sides of the Detroit River area in the vicinity of some local land-based sources of contamination.

A study of solar illumination in the City of Windsor and at Harrow, Ontario, about 25 miles south of the Detroit River, has shown that the daylight in Windsor is reduced by the presence of aerosol pollutants that attenuate the solar radiation by reflection, scattering, and absorption. The measurements at the town of Harrow are also affected by the presence of particulate pollution, of which a substantial fraction very probably originated in the Detroit-Windsor area. However, if the monthly mean illumination at Windsor is expressed as a percentage of that at Harrow, the monthly values range from a low of 80 percent in December to 96 percent in September, with a yearly mean of 92 percent. Larger differences in illumination between Windsor and Harrow have been obtained on days of relatively high pollution. The reduction in ultraviolet radiation would be greater than that for visual light. It is the ultraviolet component of light which kills bacteria and which has been shown to help prevent rickets in improperly nourished children.

Measurements of visibility have been made in Detroit with a transmissometer. Reduced light transmittance was found to be associated with winds from directions tending to bring contaminated air from major industrial sources of pollutants to the observation site. The highest visibility occurred when winds were from directions in which were located residential areas and small business establishments.

The adverse effect on property through deposition of smoke and fly ash, the action of acid gases and the soiling of surfaces by aerosol pollutants represent economic loss. This includes damages to fabrics, household equipment, merchandise, buildings, metal products and other exposed materials. It is difficult to place an exact estimate on all the economic effects resulting from contaminated air because of the varied nature of such losses and due to the lack of pertinent statistics. However, within certain limits, some relative estimates may be made with regard to the Greater Detroit-Windsor area, based on information derived from surveys of the U.S. Department of Commerce, the U.S. Geological Survey, and other sources.

After consideration of the levels of dustfall, air-borne particulate matter, sulfur dioxide, and other contaminants in the study area, the Commission's Board of Technical Advisers estimated that the economic loss from air pollution from all sources, that is, both land based and vessels, averages at least $20 per capita per year. For the approximately 3.5 million inhabitants of the Detroit River area, the total annual loss from all sources would amount to approximately 70 million dollars.

The City of Detroit has undertaken an extensive program of reconstruction and rehabilitation of the downtown area, with the erection of many modern public and office buildings. The replacement of old buildings in the waterfront area by new construction with appropriate park and other landscape development is an important feature of the plan which involves expenditures of hundreds of millions of dollars. These new developments are particularly susceptible to damage from excessive smoke from both nearby land installations and from vessels. Improvement in smoke emission from all

sources is needed to protect them. Similar considerations on a more limited scale are applicable to the City of Windsor.

A number of recreational areas are located in the region under reference, including those situated along the shores of the Detroit River and on islands in the river. Contamination of these areas by smoke detracts from their value and desirability.

FLOW OF POLLUTION ACROSS THE INTERNATIONAL BOUNDARY

Factors affecting transboundary pollution include the geographical contours of the Detroit River, the location of major industrial sources, including vessel traffic and the wind flow pattern in the study area. Thus, with the prevailing wind movement from between west and north, the pollutants originating from sources within the United States are swept across the boundary into Canada. On the less frequent occasions when the wind direction is from south to east sectors of the compass air pollutants originating on the Canadian side are carried over into the United States. With wind from other points of the compass the transboundary pollution will depend upon the location of particular major sources in relation to the contours of the Detroit River.

The actual transboundary flow of air-borne particulate pollution has been measured at pairs of sampling stations located at opposite points along both banks of the Detroit River from the southern part of Grosse Isle to the eastern end of Belle Isle. The measurements were correlated with meteorological observations in the form of a wind rose analysis. This study was carried out in the winter of 1954 at a time when there was very little vessel traffic on the river. It was found that a considerable amount of particulate pollution from sources within the River Rouge-Zug Island area of the United States passed over the Ojibway area in Canada. Lesser transboundary pollution was noted at several points along the river where there was evidence of a somewhat greater differential flow from the United States into Canada than vice versa. During the navigation season this transboundary flow is augmented by the emissions from vessels. It is clear that air circulation across the boundary is such that any substantial source of pollution on either side is a matter of concern to both countries.

THE VESSEL SMOKE PROBLEM

The type of vessel found most suitable for navigation in the Upper Lakes and Lake Erie and for accommodating the maximum volume of cargo is of 10,000 tons capacity or more and is long and narrow and not designed for transocean service. The "canaler" type required heretofore to navigate the canals of the St. Lawrence is much smaller, of 2,000 to 3,000 tons capacity, and has been used to trans-ship freight from bulk carriers to ocean-going vessels. It is anticipated that, with the opening or the St. Lawrence Seaway and the resultant ready access of the Lower St. Lawrence to Great Lakes bulk carriers, there will be an increased use of the Upper Lakes by ocean-going vessels and modification of some of the Upper Lakes vessels to make them suitable for ocean service.

At the close of 1959, the Great Lakes fleet consisted of about 702 vessels with a gross registered tonnage of about 3,500,000 tons, of which 432 vessels were of United States registry with a gross tonnage of 2,546,876 and 270 vessels were of Canadian registry with a gross tonnage of 958,341. The carrying capacity of the fleet reached the 5,000,000 gross ton mark in 1954 for the first time in history, and since has fluctuated slightly above or below this figure. About three-quarters of the total tonnage of cargo is carried by United States vessels. On the Detroit River, in an average navigation season, about 120,000,000 short tons of cargo are carried by vessels in over 28,000 passages of the river.

A survey of the various types of firing equipment installed on 199 Canadian and 417 United States vessels operating on the Detroit River indicated that about 45 percent of the Canadian vessels were equipped with oil firing or diesel engines as compared with only 25 percent of the United States vessels. However, in the vessels using coal for fuel, the United States fleet contains about a five-fold greater percentage of vessels equipped with automatic stoking devices than the Canadian fleet. Since the winter lay-up season of 1951-1952, forty-three hand-fired vessels of both fleets have been equipped with underfeed stokers. This conversion, after a relatively slow start, has been accelerated within the last few years. However, approximately 41 percent of the Canadian vessels and 34 percent of the United States vessels are still hand-fired and, in general, such vessels cannot burn coal without generating objectionable amounts of smoke.

Many of the vessels plying the Great Lakes were built in the first decade of this century. Of the total number of Canadian vessels, 37 percent are over 30 years old, and of the United States vessels about 50 percent are more than

45 years of age. However, the trend in new vessel construction, particularly on the Canadian side, has been to diesel and oil fired equipment which can operate without excessive smoke emission.

Vessels of European registry are playing a significantly increasing part in Great Lakes commerce. In 1954, such vessels numbered 100 and completed 267 trips; by 1958 this number had increased to 181 and the completed trips totalled 502. This traffic is expected to increase as a result of the opening of the St. Lawrence Seaway. However, this foreign fleet is a relatively modern one since most of the vessels are less than 10 years old and about 80 percent are powered by diesel engines.

A very large amount of information has been accumulated since 1949 on the smoke emission of vessels plying the Detroit River. Black smoke drifting shoreward from passing vessels was a familiar sight in the early years of this study. Thus, in 1949 and 1950, the discharge of objectionable smoke of No. 3 Ringelmann or darker was observed in over 85 percent of vessel passages. In these years such excessive smoke was emitted more than 50 percent of the time. The seriousness of this situation was emphasized by the large volume of vessel traffic carried on this relatively narrow waterway.

The voluntary smoke control program that has been in effect since 1952 has resulted in a major reduction in air pollution from vessels on the Detroit River. The duration of excessive smoke of No. 3 Ringelmann or darker has been decreased from the high level of 53.6 percent of the time in 1949 to only about 11.8 percent over the four-year period 1954-1957. Conversely, over the same time period, the frequency of persistence of clear conditions or No. 1 Ringelmann has increased from 18.8 to about 75 percent of the time. However, it has been evident over the last several years that hand-fired coal-burning vessels cannot consume fuel with the required efficiency to meet reasonable smoke emission standards. In fact, these hand-fired vessels now constitute the core of the vessel smoke problem and further progress can only be achieved by the large scale conversion of such hand-fired equipment to automatic firing. The lack of improvement in the smoke performance of vessels that has been noted since 1955 is highly significant and indicates that the limit of effectiveness of the voluntary control programs has been reached and that further measures are necessary for more effective control of vessel smoke.

CONCLUSIONS

The conclusions of the Commission with regard to each of the questions contained in the Reference are as follows:

Question 1.

> Is the air over, and in the vicinity of, the cities of Detroit and Windsor, on either side of the international boundary, being polluted by smoke, soot, fly ash or other impurities, in quantities detrimental to the public health, safety or general welfare of the citizens, or to property interests on either side of the international boundary line?

The Commission finds that the air under reference is being polluted on both sides of the international boundary to an extent that is detrimental to the general welfare of the citizens in communities along the Detroit River and to property interests.

Question 2.

> If the foregoing question, or any part thereof, is answered in the affirmative, to what extent are vessels plying the waters of the Detroit River, or any of them, contributing to this pollution; what other major factors are responsible and to what extent?

The Commission finds that vessels plying the waters of the Detroit River, particularly the hand-fired coal-burning vessels, contribute seriously to pollution of the air over, and in the vicinity of, the cities of Detroit and Windsor and other communities along the river on both sides. Although the voluntary control program instituted by the Commission through the Technical Advisory Board has effected a considerable improvement in smoke pollution from vessels, as compared with conditions prior to 1954, the excessive smoke emission from about 25 percent or more of the vessels, nearly all in the hand-fired class, is still a source of pollution that is detrimental to the general welfare of the citizens and to property interests on both sides of the international boundary. Notwithstanding the voluntary control program, the number of vessels that have been observed to discharge dark or black smoke of Nos. 3, 4, and 5 Ringelmann in over 50 percent of their Detroit River passages have ranged from 143 to as high as 209 in the years since 1953. These violations of the voluntary standards of smoke emission represented 28 to 35 percent of all observed passages of the river.

The Commission finds that other major factors responsible for the detrimental pollution are the relatively high levels of dustfall, airborne particulate impurities and gaseous contamination, such as sulfur dioxide from numerous industrial installations and other sources on land, including the combustion products of large quantities of fuel. The concentrations are influenced by variable meteorological factors and show both diurnal and seasonal effects. A contributing factor to the levels of pollution is the transfer of pollution from each side of the boundary to the other along the Detroit River, much the most serious effect involving the flow of impurities from the River Rouge-Zug Island area of the United States to the Canadian side.

Industrial, domestic and transportation activities on land contribute to the overall pollution of the air to a much greater extent than vessels plying the river if consideration is given only to average pollution levels over the entire study area. However, air pollution from vessels represents an intermittent but visible source that is more evident in its effects in a narrow belt adjoining both sides of the Detroit River than in areas farther inland. The vessels ply the river in relatively close proximity to residential, recreational, and civic land developments that are thus subjected to the harmful influence of drifting smoke and fly ash, readily identifiable as to their source.

Question 3.

> If the Commission should find that vessels plying the waters of the Detroit River, or any of them, are responsible for air pollution to an extent detrimental to the public health, safety or general welfare of the citizens, or to the property interests on either side of the international line,
>
> (a) what preventive or remedial measures would, in its judgment, be most practical from the economic, sanitary and other points of view?
>
> (b) what would be the probable cost of such measures?
>
> (c) by whom should such cost be borne?

In the judgment of the Commission a limit has been reached under the voluntary control program in the abatement of air pollution from vessels plying the Detroit River. It is clear that continued surveillance should be maintained

and that some form of continuing regulation be enforced to ensure that there is no appreciable lapse in the performance achieved under the voluntary control program. For landbased sources, industries operating within the corporate limits of the cities of Detroit and Windsor and many other municipalities within the Detroit River area are subject to air pollution control regulations as outlined in the chapter on Legislation and Regulation in the appended report of the Technical Advisory Board. Within the United States the provisions of such regulations apply equally to railway and other forms of transportation on land. Within Canada the control of air pollution from railway operations comes under the jurisdiction of the Board of Transport Commissioners for Canada.

The Commission is convinced that advances in technology have made it possible, by use of modern fuel-burning equipment, to burn both solid and liquid fuels efficiently and thus prevent the discharge of excessive smoke. The great majority of vessels equipped with automatic firing installations such as diesel engines, oil-fired furnaces, under-feed and spreader stokers have shown satisfactory progress in smoke abatement and will have little difficulty in avoiding excessive smoke emission. The main problem in the control of atmospheric pollution from shipping is that presented by the hand-fired vessel.

Most of the hand-fired vessels on the Great Lakes are equipped with Scotch marine boilers, although some have watertube boiler installations. Such vessels could burn coal more efficiently and with less objectionable smoke by conversion to automatic firing. Another possible solution for hand-fired vessels is conversion to oil-firing. Most of the larger vessels containing water-tube boilers and fired by coal are equipped with spreader stokers. The principal economic problem associated with eliminating excessive smoke from vessels of the Scotch marine boiler class is the cost of conversion to either automatic stoking or oil-firing.

With respect to Detroit River shipping, there are approximately 200 hand-fired vessels equipped with Scotch marine boilers. Of the 200 vessels, some are small "canalers" of about 2,000 to 3,000 tons gross cargo-carrying capacity, but the proportion of these to the total shipping is somewhat lower in the Detroit River than in the lower reaches of the Great Lakes system. The problem of converting "canalers" or replacing them with vessels of greater cargo capacity is, therefore, less acute in the Detroit River than in the lower Lakes.

Since the winter lay-up period of 1951-1952, more than 40 hand-fired vessels have been converted to underfeed stoker firing under the voluntary control program. In 1955, the costs for stoker, automatic controls, fuel handling system and installation were about $60,000 to $65,000 for a six-furnace vessel, and about $45,000 to $50,000 for a four-furnace vessel. Estimates of current costs run as high as $100,000 for a six-furnace vessel. To offset this capital cost, certain savings may be accomplished through a reduction in coal consumption of as much as nine or ten percent, a decrease in the labor force, or both. Thus, for a six-furnace hand-fired vessel, the normal complement of six firemen and coal passers can be reduced to three on conversion to underfeed stoking.

A number of vessels have been converted from hand-firing to oil-firing and many of the newly commissioned vessels in recent years have been equipped with oil burners. For a six-furnace vessel, the investment for burners, automatic controls, fuel storage and installation varies from $80,000 to $100,000. Although fuel costs are, of course, higher for oil-firing, substantial savings can be effected through increased average speed, which may enable the vessel to make at least one extra trip per season; through reduction in fuel bunker space by 50 percent, which permits a corresponding increase in cargo space; and through a substantial decrease in the labor force of firemen and coal passers.

The Commission is of the opinion that the possible savings mentioned above are substantial and that, for vessels of sufficient cargo-carrying capacity, the costs of conversion to either automatic stoking or oil firing would be repaid within a reasonable number of years. At an average cost of about $75,000 per vessel, the above conversion program for 200 vessels would entail a total expenditure of about $15,000,000.

For vessels of small cargo carrying capacity, designed within the limits set for navigating the St. Lawrence River fourteen foot canals, the foregoing considerations do not apply because they only carry one man per shift to fire furnaces so that no laborsaving is possible after conversion. Formerly these "canalers", with a carrying capacity of 2,000 to 3,000 tons, filled an economic need. Some seven or eight canalers were required to keep a single large Upper Lakes bulk carrier in operation and they have been a significant factor in the Great Lakes shipping economy, particularly with respect to

the Canadian fleet. With the completion of the St. Lawrence Seaway, however, the significance of the canaler in the economy is greatly reduced, and it is expected that they will be withdrawn from this service, perhaps within a few years, or replaced by vessels better adapted to the changed operating conditions. Excessive smoke emission by canalers is, therefore, an interim problem that will disappear in a few years and for which no economical remedial measures are available.

For the larger hand-fired vessels that will remain in service in the face of competition from other Great Lakes and foreign vessels, there are at hand practical remedial measures for control of smoke and fly ash. However, as there are insufficient resources available in equipment and manufacturing facilities to meet the problem of the immediate conversion of large numbers of hand-fired vessels to more modern firing methods, a reasonable time period should be allowed for the installation of such equipment.

The Commission considers that the costs of the remedial measures necessary for abatement of air pollution from vessels should be borne solely by the owners of such vessels.

With respect to air pollution originating from sources other than vessels, the Commission believes that there is adequate legal and administrative authority in each country to enforce proper control of the emission of objectionable waste products. With regard to air pollution from vessels, the existing legislation is applicable only to certain limited aspects of the problem and consideration should therefore be given in each country to the additional legislation necessary to ensure adequate control of pollution from vessels.

Application of the Detroit and Windsor smoke ordinances to ship in transit in the Detroit River has to date proved impractical. This is because the ship channels in the Detroit River cross and recross the boundary between the United States and Canada, and ships can pass from one jurisdiction to another so rapidly that ordinance violations are at times impossible to establish. A minimum observation period exceeding four minutes is required to establish a violation of these ordinances. In addition, as most of the ships do not stop in Detroit or Windsor, the service of notice of violation on the appropriate persons and the appearance of such persons for hearings or trials are difficult or impossible to effect. For these reasons, the Commission believes that procedures must be found to overcome impediments to enforcement of smoke emission standards on the Detroit River

RECOMMENDATIONS

(1) The Commission recommends that the objectives for emission of smoke from vessels plying the Detroit River as set forth in this report be adopted by the two Governments as the criteria to be met in maintaining the atmosphere over, and in the vicinity of, these boundary waters in satisfactory condition. Furthermore, the Commission recommends that appropriate action be taken in each country to ensure that these objectives are met.

OBJECTIVES FOR EMISSION OF SMOKE FROM VESSELS PLYING THE DETROIT RIVER

(a) The objective for all vessels, except for an interim period for hand-fired vessels, shall be:

No smoke, the shade or appearance of which is equal to or darker than No. 2 of the Ringelmann Chart shall be emitted, except that smoke the shade or appearance of which is equal to but not darker than No. 2 of the Ringelmann Chart for a period or periods aggregating not more than 4 minutes in any 30 minutes shall be permitted;

(b) For an interim period determined as recommended below, the objective for hand-fired vessels shall be:

No smoke, the shade or appearance of which is equal to or darker than No. 3 of the Ringelmann Chart shall be emitted, except that smoke the shade or appearance of which is equal to but not darker than No. 3 of the Ringelmann Chart for a period or periods aggregating not more than 9 minutes in any 30 minutes shall be permitted;

(c) For the purpose of grading the shade or appearance of smoke, the Ringelmann Chart as published and used by the U.S. Bureau of Mines, shall be the standard, but the use of any other chart or device having shades equivalent to those of the Ringelmann Chart shall be acceptable.

(2) The Commission recommends that these objectives be applicable to vessels in transit in the area under reference.

(3) The Commission recommends that at such time as the two Governments shall determine that it would be in the best interests of Canada and the United States to do so, the objectives set forth herein be amended by deleting

therefrom the interim exception in favor of hand-fired vessels.

(4) As questions relating to the legal, administrative and other details of enforcement require further study for resolution at various government levels, the Commission recommends that each Government develop legal and administrative procedures for dealing with noncompliance with the regulations of the several jurisdictions with respect to air pollution from vessels; develop appropriate methods for establishing proof of such noncompliance; study and resolve related questions such as the definition of the jurisdictions of courts concerned with the enforcement of regulations which now exist or may be adopted, and of extenuating circumstances under which deviations from such regulations should be permitted.

(5) As a procedure to ensure that there shall be no relaxation of existing efforts to abate air pollution from vessels on the Detroit River in any interim period that may elapse until implementation of effective regulations or the resolution of legal, administrative and jurisdictional matters, or until appropriate machinery has been set up to establish the control of air pollution on a satisfactory working basis, the Commission recommends that it be specifically authorized by the two Governments to establish and maintain continuing surveillance of air pollution from vessels in the Detroit River area through a board appointed by the Commission. In carrying out this surveillance, the Commission would continue to conduct a program of observation and control of vessel smoke emission on the Detroit River on a voluntary basis in cooperation with governmental and shipping interests concerned.

(6) In order that owners and operators, captains and engineers of vessels may be assisted in their efforts to comply with emission limitations on a uniform basis, the Commission recommends that appropriate jurisdictions be encouraged to adopt with respect to vessels, regulations which conform to the objectives herein recommended to the two Governments so that vessels will be subject to uniform regulations.

(7) All costs incurred for vessels to meet the objectives herein recommended should be borne by the owners of the vessels.

Signed at Ottawa, Canada the 31st day of May, 1960

Eugene W. Weber

A. G. L. McNaughton

Francis L. Adams

J. Lucien Dansereau

D. M. Stephens

The report of the Technical Advisory Board referred to in the foregoing report of the Commission is available in the offices of the Commission in Washington and Ottawa.